

Ultrasonographic Assessment of Radial Neuropathy Caused by Traumatic Neuroma

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A patient presented with wrist drop, hand paresthesia, and no apparent history of injury to the hand. Electrodiagnostic testing suggested a radial nerve lesion between the triceps brachialis and extensor digitorum communis with poor reinnervation. The radial nerve was traced by ultrasound, from the axilla to the forearm, and a small comet-shaped mass was identified over the nerve above the elbow joint line. Magnetic resonance imaging of the affected elbow similarly revealed a nodular lesion along the distribution of the radial nerve. The patient underwent surgical excision of the lesion; histopathologic examination revealed a traumatic neuroma. Anatomic information from high-resolution ultrasound can complement neurophysiologic findings with a high degree of accuracy. Because it is inexpensive, noninvasive and dynamic, ultrasound should always be performed as a preliminary screen in patients who present with features of neurologic lesions of the extremities.

KEY WORDS — neuroma, radial nerve, ultrasonography

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Introduction

The usual cause of wrist drop is radial nerve palsy. The current diagnostic methods include detailed history taking, physical examination, nerve conduction studies (NCSs), and electromyography (EMG) for identifying the level of the lesion. High-resolution ultrasound (US) may increase diagnostic power to identify nerves and fine structural details [1,2] and, therefore, may be sensitive enough to screen for neurologic lesions of the extremities and to guide the subsequent workup of these disorders [3]. We report a case of wrist drop due to radial nerve palsy; the radial nerve was traced with US from the axillary level to the forearm. A mass lesion arising from the

radial nerve was noted between the brachioradialis and brachialis muscles; neuropathologic examination revealed a traumatic neuroma.

Case Report

An 11-year-old boy presented with left hand weakness and wrist drop. A grandparent who raised the boy did not remember any trauma or when hand weakness first appeared. Manual muscle testing demonstrated severe weakness (1/5, 1-trace strength; 5-normal strength) of wrist extension, wrist in ulnar or radial deviation, and second to fourth fingers extension, and normal strength with forearm

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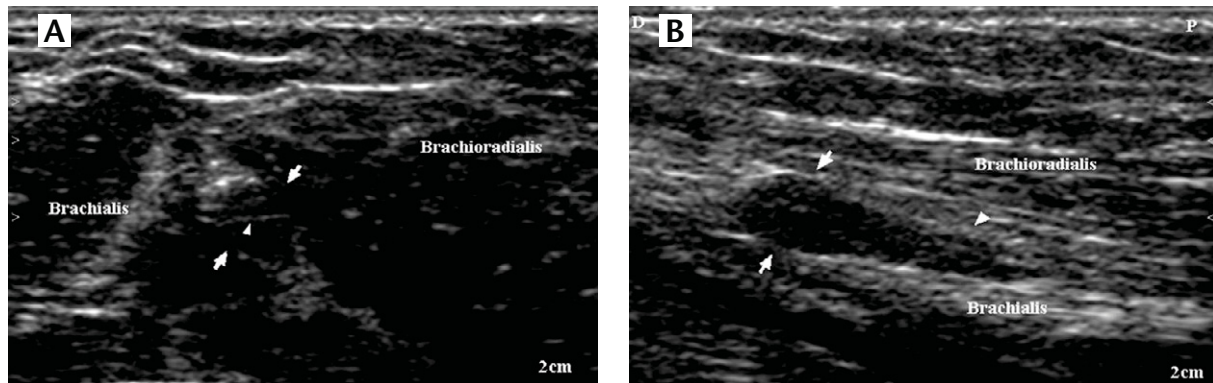


Fig. 1. (A) An oval cyst-like lesion with a septum, located between the brachioradialis and brachialis muscles, is shown on transverse scan of the left radial nerve. The arrows mark the boundaries of the lesion and the arrowhead points to the septum. (B) A small comet-shaped hypoechoic mass measuring about 0.42×1.45 cm along the radial nerve between the brachioradialis and brachialis muscles, 2 cm above the elbow joint line, is noted on longitudinal scan of the left radial nerve. The arrows outline the comet head distally and the arrowhead points to the comet tail proximally connected to the radial nerve. D = distal; P = proximal.

pronation, elbow flexion, extension, shoulder abduction, and rotation. Mild paresthesia was present over the dorsum of the left hand, and the Tinel sign was equivocal; no tenderness or palpable mass was noted. Deep tendon reflexes of triceps and biceps brachii were normal. NCSs revealed absent compound muscle action potential (CMAP) and a low sensory nerve action potential (SNAP) of the left radial nerve, while EMG studies showed abnormal activity of muscles that receive innervation from the posterior interosseus nerve (including the extensor indices proprius [EIP] and extensor digitorum communis [EDC]) but normal activity of the triceps brachii. From this, we concluded that the nerve lesion level was located between the triceps brachii and EDC and that these muscles were poorly reinnervated.

High-resolution 3–12 MHz broadband linear array EnVisor HD (Philips Medical Systems, Bothell, WA, USA) US was used to study the radial nerve. The hypoechoic fascicular pattern of the proximal radial nerve from its origin in the posterior cord of the brachial plexus to the level of the lateral epicondyle was intact. About 2 cm above the elbow joint line (which was the location suggested by electrodiagnostic testing), a small well-defined comet-shaped hypoechoic mass measuring about 0.42×1.45 cm located along the hyperechoic radial nerve between the brachioradialis and brachialis muscles was noted on longitudinal scan. On transverse scan,

it appeared as an uncompressed oval hypoechoic mass with a septum and no posterior acoustic enhancement (Fig. 1). Color Doppler scan showed no increase in vascularity around the mass and poor blood flow within it. Gadolinium-enhanced magnetic resonance imaging (MRI) of the left elbow revealed a nodular lesion along the distribution of the radial nerve (Fig. 2). The lesion was located on the deep branch of the radial nerve with an intact compressed superficial branch overlying it; the tumor was excised and the deep branch was repaired (Fig. 3). The tumor was sent for histopathologic examination, which showed traumatic neuroma. Post-operatively, the paresthesia, weakness of the wrist, and finger extension improved.

Discussion

Electrodiagnostic tests are useful in assessing nerve integrity, functionality, severity of damage, distribution of nerve injury, and for monitoring reinnervation, but they only reflect function and do not show the detailed anatomy of a nerve [4]. High-resolution imaging studies such as MRI provide fine anatomic detail of soft tissue, and can be used to visualize nerve structures, but its high cost and time requirement limit its use in routine clinical practice [5]. US is an inexpensive and noninvasive

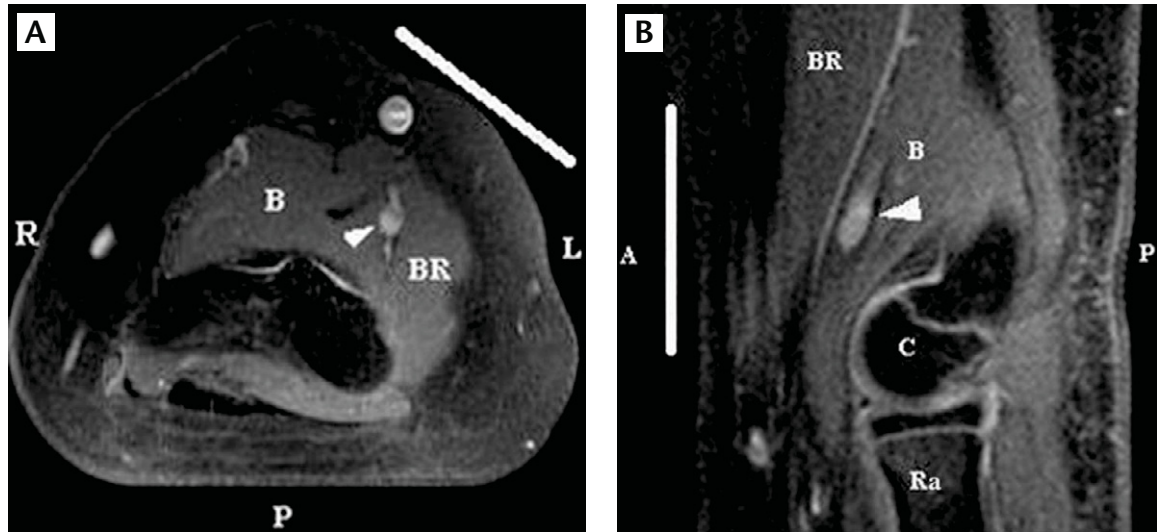


Fig. 2. Nodular lesion (arrowheads) along the distribution of the radial nerve is seen on T1-weighted magnetic resonance imaging with contrast enhancement: (A) axial view; (B) sagittal view. The white bar represents the location of the linear probe with respect to Fig. 1: the probe position in 2A corresponds to that in 1A, and that in 2B corresponds to that in 1B. R = right; L = left; A = anterior; P = posterior; B = brachialis; BR = brachioradialis; C = capitulum; Ra = radius.

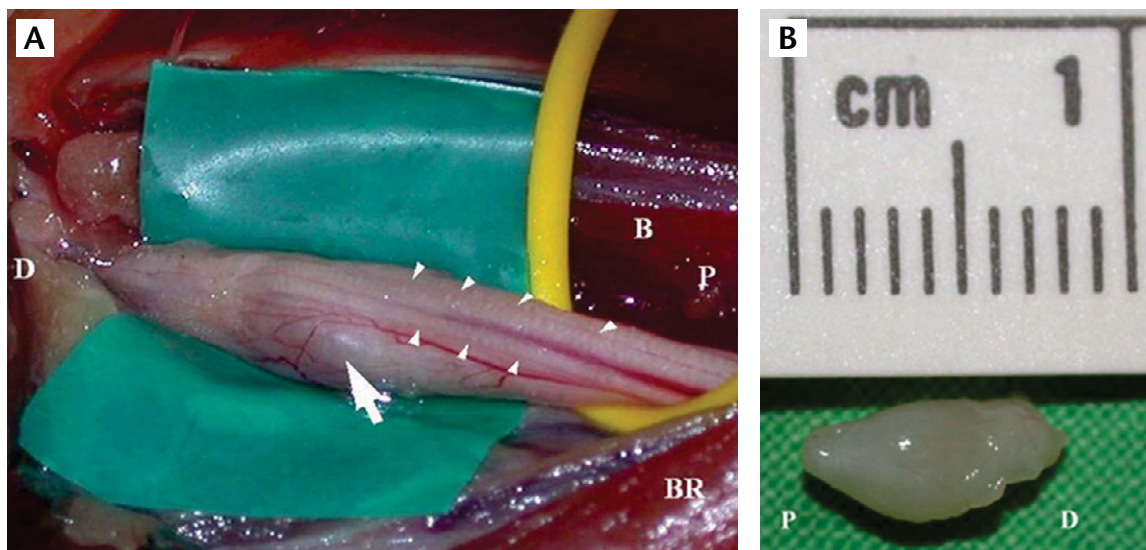


Fig. 3. (A) The white arrow indicates the nodular lesion in the deep branch of the radial nerve, and the arrowheads mark the boundaries of the superficial branch that was compressed by the tumor in the radial tunnel. D = distal; P = proximal; B = brachialis; BR = brachioradialis. (B) The gross specimen is a whitish, elastic mass with proximal thin smooth stalk, but rough bulky distal end, compatible with the comet shape seen on longitudinal sonogram. P = proximal; D = distal.

method for examining superficial tissues such as muscles, tendons, joints, and other soft tissues [6]. High-resolution US is suited for use in electrodiagnostic laboratories, where it can provide anatomic correlation with neurophysiologic findings [7]. Our case notably illustrates the utility of combining electrodiagnostic testing with high-resolution US

to accurately identify the level of the lesion as well as provide detailed anatomic information.

Clinical evaluation of the brachial plexus is very difficult as it is inaccessible to palpation [8]. US has been used to visualize the brachial plexus [9,10] and to guide percutaneous anesthesia [11,12]. Various components of the brachial plexus cord appear

hyperechoic on US in the infraclavicular area and hypoechoic in the axillary and interscalene regions [13]. In 1988, peripheral nerves were described as echogenic fibrillar structures [14], whereas more recently, they have been described as hypoechoic if adjacent tissues are hyperechoic [15]. US can reveal severe damage to the radial nerve, such as laceration or gross impingement by displaced bone fragments, scar tissue, or callus [16]. In our case, US was able to trace the radial nerve from the posterior cord of the brachial plexus to the distal forearm, and both the longitudinal and transverse planes of the nerve and other soft tissue structures were examined. Our identification of a tumorous lesion along the radial nerve illustrates the fact that high-resolution US can readily detect peripheral nerve lesions.

Peripheral neurogenic tumors are relatively uncommon and particularly rare in children [17]. Their margins are well-defined and the nerve of origin is frequently seen entering or exiting the tumor. Benign neurogenic tumors are classified as neurofibromas, schwannomas (or neurilemmomas), and traumatic neuromas [6,17]. A traumatic neuroma is located at the end of a severed nerve, whereas a schwannoma is eccentric and a neurofibroma is central in relation to the involved nerve [18,19]. On MRI, neurogenic tumors appear isointense to muscle on T1-weighted images and show hyperintense signals on both proton-density and T2-weighted images [18]. All these neurogenic tumors are usually in a relatively superficial location and therefore suitable for US assessment [6]. Neurogenic tumors are treated by surgical excision and final clinical diagnosis is based on histopathologic examination; however, neurofibromas are very difficult to excise and attempted removal may result in neurologic deficit.

Traumatic, stump or amputation neuroma occurs when a nerve is transected, whether or not the limb is amputated. It develops when the regenerating axonal sprouts growing distally from the cut end fail to enter the endoneurial tubules of the distal part of the damaged nerve within 1–12 months after transection. US of traumatic neuroma demonstrates a comet shape, with the head being an oval well-defined hypoechoic poorly vascularized mass or

cyst, and the tail a proximal intact echogenic nerve running into the mass [6,7,20,21]. On the other hand, schwannomas increase intrinsic blood flow and present with posterior acoustic enhancement [14,19,22,23]. Since the mass in our case could not be compressed with a probe and there was no posterior enhancement, it was not a ganglion [21].

High-frequency US is a highly sensitive detector of neurogenic tumors of the extremities; however, its sensitivity is reduced when the nerve lies deeper than 3 cm and when a linear-array transducer of less than 7 MHz is used [24]. Limitations of US are the need for expert interpretation of abnormal peripheral nerve conditions and the requirement of an experienced operator.

In conclusion, neurophysiologic findings can help to localize the range of the lesion and reduce the time spent on US; anatomic information from high-resolution US can complement neurophysiologic findings with a high degree of accuracy. Because US is inexpensive, noninvasive and dynamic, it should always be performed as a preliminary screen in patients who present with features of neurologic lesions of the extremities, thereby avoiding expensive imaging modalities such as MRI.

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